Exploring the Spin Structure of the Proton with Two-Body Partonic Scattering at RHIC

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Extensive studies in deep inelastic scattering have demonstrated quark spins contribute only a small portion of the spin of the nucleon[1]. However, the contributions of gluons are, so far, poorly known due to their weak interaction with electromagnetic probes. With the advent of polarized proton beams at the Relativistic Heavy Ion Collider and its major detectors STAR and PHENIX, a new window to the gluon spin contributions, ΔG, is opened by studying hard 2-body partonic collisions involving the gluons and their spin sensitivities directly. Processes such as $\vec{q} + \vec{g} \rightarrow q + g$ and $\vec{g} + \vec{g} \rightarrow g + g$ result in jets of particles well suited for a large solid angle detector such as STAR. Of interest is the longitudinal double spin asymmetry

$$A_{LL} = \frac{\sigma^{++} - \sigma^{--}}{\sigma^{++} + \sigma^{--}}$$

where σ^{++} and σ^{--} represent the cross sections for beams with the same or opposing helicities. This quantity when measured for inclusive jet production, as well as the π^0 component of the jets, are sensitive to the polarization of the struck gluons[2] as shown in Figure 1. These reactions have large cross sections and hence are well suited to the growing luminosities and polarizations in the early runs.

Measurements of A_{LL} from a low statistics development run in 2004 for π^0s from PHENIX[3] and jets from STAR[4] have demonstrated the promise of the technique. About 1/2 of the 2005 RHIC run was devoted to polarized proton measurements collecting $\sim$3pb^{-1} of integrated luminosity and over 5 million jets above 5 GeV transverse momentum, p_T. The expected statistical precision for A_{LL} is shown in Figure 1. Results for the 2005 data are in preparation and are expected to be available for presentation at the conference.

In the future, STAR's goal is to measure $\Delta g(x)$, i.e. not just the integral ΔG but the x dependence from $0.01 \leq x \leq 0.3$. This will be done by measuring A_{LL} for detected direct-photon jet coincidences resulting from the QCD Compton scattering process $\vec{q} + \vec{g} \rightarrow q + \gamma$. The experimental signal is relatively clean and the QCD Compton subprocess dominates other partonic subprocesses with the same experimental signal. We expect the 2006 run, which will finish in the early summer, will provide sufficient statistics to observe this rare process and allow tuning of techniques for runs in the future. While results will not be available from the 2006 run at the conference, a status report on the data collected will be provided.

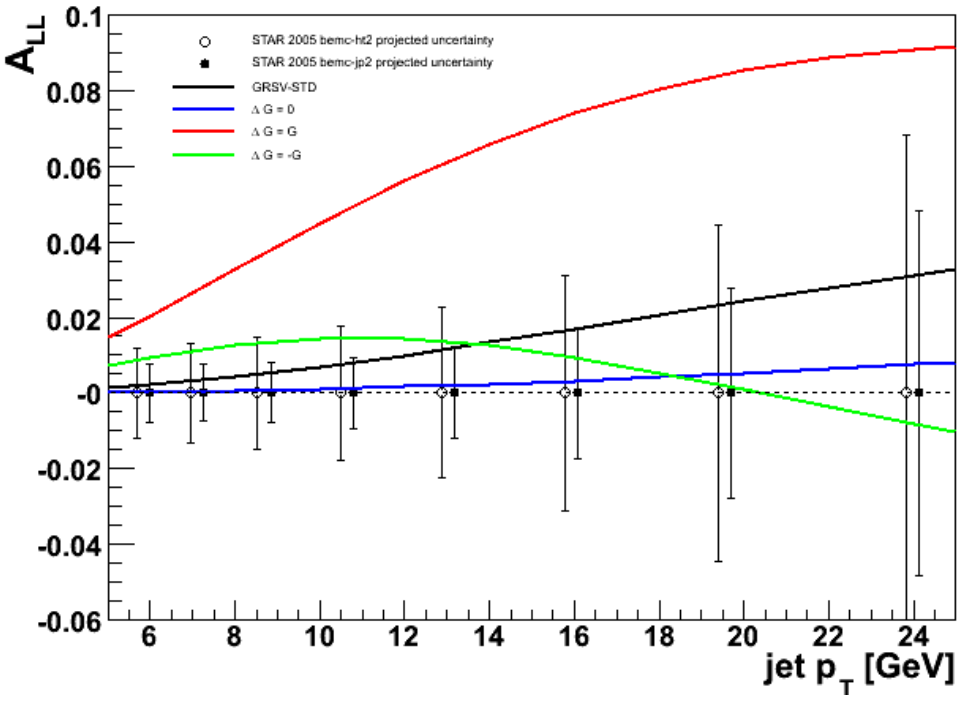

Figure 1: Sensitivity of A_{LL} for inclusive jets to ΔG and projected statistical precision of 2005 data. The curves are next-to-leading order pQCD calculations[2] for different assumptions about the gluon polarization, the two extremes of the gluons being fully polarized either along (ΔG=G) or anti-aligned (ΔG=-G) with the proton spin, unpolarized (ΔG=0) or at a value typical of fits to DIS data (GRSV-std). The plotted points illustrate the expected precision from data taken in the 2005 run for two different trigger samples.

References

1. G. Bunce *et al.*, Ann. Rev. Nucl. Part. Sci., 525 (2000).
2. B. Jager, M. Stratmann, W. Vogelsang, Phys.Rev. D**70**, 034010 (2004).
3. S.S. Adler *et.al.*, The PHENIX Collaboration, Phys. Rev. Lett. **95**, 202001 (2005) .
4. J. Adams *et.al.*, The STAR Collaboration, in preparation.